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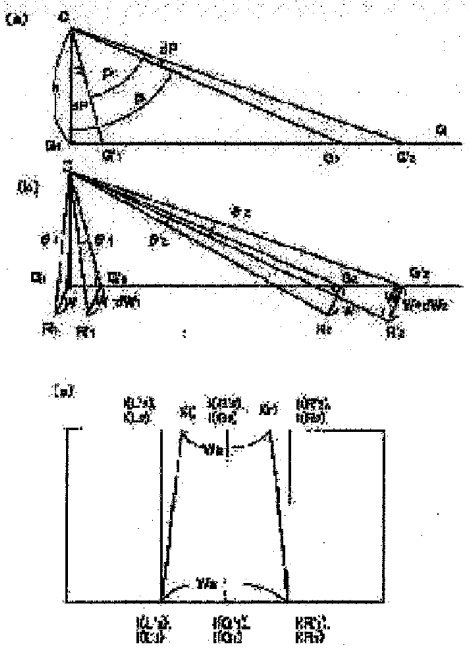
(54) IMAGE PICKUP AND IMAGE CONVERSION DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To automatically detect the variation of a camera pitch angle from picked-up lane marks and automatically adjust a converted image.
SOLUTION: The image pickup and image conversion device loaded in a vehicle and fixed on a point C of height (h) and capable of picking up the image of a road surface on the back of the vehicle from a camera and converting the picked up image into a bird's-eye mage detects lane marks to be parallel lines and judges whether the lane marks are parallel lines or not. When the lane marks are not parallel lines, the variation dP of the camera pitch angle Pc is obtained from width Wi1 on a position most close to the vehicle in the bird's eye image, width Wi2 on a position most far from the vehicle and an angle P in the vertical direction of the camera in an area to be converted into the bird's-eye image and Pc+dP is substituted for the camera pitch angle to prepare a bird's-eye image again.



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CLAIMS

Claim(s)]
Claim 1] The image pick-up and the image-transformation equipment which amend the image pick-up direction parameter of the image pick-up means which said image-transformation means has based on the analysis result of said image-analysis means, and are characterized by to constitute so that the amended resolution picture may make output in the image pick-up which has an image pick-up means, an image-transformation means changes the image pick-up image of the image pick-up means, and output an resolution picture, and an image-analysis means analyze said image pick-up image, and image-transformation equipment.
Claim 2] The image pick-up and the image-transformation equipment which amend the image pick-up direction parameter of the image pick-up means which said image-transformation means has based on the analysis result of said image-analysis means, and are characterized by constituting so that the amended resolution picture may make output in the image pick-up which has an image pick-up means, an image-transformation means change the image pick-up image of the image pick-up means, and output an resolution picture, and an image-analysis means analyze the resolution picture which the image-transformation means outputs, and image-transformation equipment.
Claim 3] Said image pick-up means is the image pick-up according to claim 1 or 2 and image transformation equipment which are characterized by being attached in a car and mainly picturizing a road surface.
Claim 4] Said image analysis means is the image pick-up according to claim 3 and image transformation equipment which are characterized by determining the amount of amendments of said image pick-up direction parameter by presuming and extracting the parallel lines or the known graphic form on a road surface, and analyzing the image pick-up image or resolution picture of these parallel lines or a known graphic form.
Claim 5] Said image analysis means is the image pick-up according to claim 3 and image transformation equipment which are characterized by determining the amount of amendments of said image pick-up direction parameter by the rate measurement means of a car being interlocked with by analyzing the image pick-up image or resolution picture of an optical flow on a road surface.
Claim 6] It is the image pick-up according to claim 3 and image transformation equipment which are characterized by determining the amount of amendments of said image pick-up direction parameter by analyzing the resolution picture having predetermined distance, arranging two or more of said image pick-up means, and according to the image pick-up image of the image pick-up means of these plurality [means / said / image analysis], or said image transformation means.
Claim 7] An image pick-up and image transformation equipment given in any 1 term of claim 3 characterized by for an attitude-sensing means to detect the direction of an image pick-up means being arranged by said image pick-up means, using together the direction parameter of the image pick-up means against the car which this attitude-sensing means detects, and determining the amount of amendments of said image pick-up direction parameter thru/or claim 6.

Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the image pick-up and image transformation equipment which change into an resolution picture the image pick-up image picturized by the image pick-up means with an image transformation means, and output it. What changes the image pick-up image specifically obtained by picturizing a road surface etc. aslant into the top view picturized and obtained from the upper part before outputting to for example, image recognition equipment is mentioned. This invention is effective in the image pick-up which provides an operator etc. with the top view (bird's-eye view) from the upper part in operation of operation of a car etc., a vessel, the aircraft, etc., and external observation especially, and especially image transformation equipment.
[0002]
[Description of the Prior Art] For example, JP,2946727,B and JP,7-218280,A are known as the image pick-up which picturizes the road surface and road situation of the front or back to the operator of a car, and provides him with the top view (bird's-eye view) from the upper part, and image transformation equipment. These fix image pick-up equipment as a design including the image pick-up direction beforehand, and input the parameter.
[0003]
[Problem(s) to be Solved by the Invention] Like a passenger car, by a car body's sinking or inclining with the entrainment number and the amount of loads, when the location and the image pick-up direction of image pick-up equipment differ from the parameter inputted or it was designed, in a place, they may happen frequently. Then, while running the road surface which has completely parallel lane space marks, for example, even if it is going to obtain the top view (bird's-eye view) from the upper part from an image pick-up and image transformation equipment, distortion will arise.
[0004] This is shown in drawing 8 . As shown in (a) of drawing 8 , when the pitch angle Pc (the apparent vertical passing through the lens core of Camera C and angle which the image pick-up direction of a camera constitutes) of the camera C formed in Car M is alpha, the image pick-up image ((b) of drawing 8) presupposes that the processor is constituted so that it may become a right resolution picture ((c) of drawing 8). That is, when the parallel lines on a road surface (a thick segment and broken line) are picturized, an resolution picture presupposes that it is adjusted so that it may become parallel lines. When the pitch angle of a camera becomes large with alpha+d alpha (dalpha> 0) or becomes small with alpha-d alpha (dalpha> 0) at this time, that image pick-up image becomes like (d) of drawing 8 , (a horizontal line H becoming a low location among an image pick-up image), (e), and (a horizontal line H becoming a high location among an image pick-up image). Then, since the approach of image transformation is to change into the frame of the screen of (c) of drawing 8 , (f), and (g) the field surrounded by the dotted line of (b) of drawing 8 , (d), and (e), the resolution picture of (d) of drawing 8 and (e) will become like (f) of drawing 8 , and (g). That is, an resolution picture did not become a top view (bird's-eye view) from the right upper part with the inclination of a car, but there was a problem that right information was not directed to an operator even if it outputs to image recognition equipment.
[0005] Accomplishing this invention in order to solve the above-mentioned technical problem, the purpose is offering the image pick-up and image transformation equipment which were constituted so that the resolution picture amended by carrying out automatic amendment of the image pick-up direction of image pick-up equipment might be outputted.
[0006]
[Means for Solving the Problem] In the image pick-up which has an image pick-up means, an image transformation means to change the image pick-up image of the image pick-up means, and to output an resolution picture, and an image analysis means to analyze an image pick-up image according to the means according to claim 1 in order to solve the above-mentioned technical problem, and image transformation equipment It is characterized by constituting so that the image pick-up direction parameter of the image pick-up means which an image transformation means has based on the analysis result of an image analysis means may be amended and the amended resolution picture may be made to output. This is shown in drawing 1 (a) as a block diagram. In addition, as an image pick-up direction parameter, they are the locations (camera height etc.) of an image pick-up means, the angle (pitch angle) of the direction of an image pick-up core, and the straight line taken down downward [vertical] from the image pick-up means to accomplish, the angle (horizontal Bure angle) of those flat surfaces to make and the direction of a setting image pick-up core set up to accomplish, and angle of torsion of the image pick-up means centering on the direction of an image pick-up core.
[0007] Moreover, an image transformation means to change the image pick-up image of an image pick-up means and its image pick-up means according to the means according to claim 2, and to output an resolution picture, In the image pick-up which has an image analysis means to analyze the resolution picture which the image transformation means outputs, and image transformation equipment It is characterized by constituting so that the image pick-up direction parameter of the image pick-up means which an image transformation means has based on the analysis result of an image analysis means may be amended and the amended resolution picture may be made to output. This is shown in drawing 1 (b) as a block diagram. In addition, as an image pick-up direction parameter, they are the locations (camera height etc.) of an image pick-up means, the angle (pitch angle) of the direction of an image pick-up core, and the straight line taken down downward [vertical] from the image pick-up means to accomplish, the angle (horizontal Bure angle) of those flat surfaces to make and the direction of a setting image pick-up core set up to accomplish, and angle of torsion of the image pick-up means centering on the direction of an image pick-up core.
[0008] Moreover, according to the means according to claim 3, in an image pick-up according to claim 1 or 2 and image transformation equipment, it is characterized by attaching an image pick-up means in a car, and mainly picturizing a road surface. In addition, a road surface is not limited to the so-called road, but means all the fields where a car moves. That is, a parking field is included.
[0009] Moreover, according to the means according to claim 4, an image analysis means presumes and extracts the parallel lines or the

known graphic form on a road surface, and is characterized by determining the amount of amendments of the image pick-up direction parameter by analyzing the image pick-up image or resolution picture of these parallel lines or a known graphic form. Road surface-like parallel lines mean the road shoulder, lane space marks, a parking field partition line, etc., and a known graphic form means road surface dispplay of a circular manhole, a stop line, and a travelling direction and others etc. here, for example.

[0010] Moreover, according to the means according to claim 5, an image analysis means is characterized by determining the amount of amendments of the image pick-up direction parameter by the rate measurement means of a car being interlocked with by analyzing the image pick-up image or resolution picture of an optical flow on a road surface. An optical flow means what is recognized by the image analysis means as what moves in an image pick-up image or resolution picture top here like the lane space marks of the shape of a broken line formed in the road surface.

[0011] Moreover, according to the means according to claim 6, it has predetermined distance, two or more image pick-up means are arranged, and an image analysis means is characterized by determining the amount of amendments of the image pick-up direction parameter by analyzing the image pick-up image of the image pick-up means of these plurality, or the resolution picture by said image transformation means.

[0012] Moreover, according to the means according to claim 7, it is characterized by for an attitude-sensing means to detect the direction of an image pick-up means being arranged by the image pick-up means, using together the direction parameter of the image pick-up means against the car which this attitude-sensing means detects, and determining the amount of amendments of the image pick-up direction parameter. An attitude-sensing means means the combination and others of a gyroscope, an acceleration detector, and a computing element here.

[0013]

[Function and Effect(s) of the Invention] When the image pick-up means has not turned to the image pick-up direction as a setting, it can ask for the gap with the set point of the image pick-up direction of an image pick-up means by analyzing an image pick-up image or an resolution picture with the means of claim 1 of this application, or claim 2. Therefore, the amended resolution picture can be acquired by amending the image pick-up direction parameter in an image transformation means, without adjusting the image pick-up means itself. Therefore, fine tuning becomes unnecessary in the case of immobilization of an image pick-up means. As such an image pick-up and image transformation equipment, after picturizing a road surface etc. aslant, for example, it is effective in especially the image pick-up and image transformation equipment that form the top view (bird's-eye view) from the upper part. By this, you can make it for example, image recognition equipment interlocked with, a more exact circumference situation can be recognized, and circumference status information can be given to an operator, a monitor, etc.

[0014] If an image pick-up means is attached in a car and the image pick-up image or resolution picture of a road surface is analyzed, the amount of amendments of the image pick-up direction parameter can be determined easily (claim 3). According to analysis of the parallel lines on a road surface, a known graphic form, and an optical flow, it is especially easy and certain (claims 4 and 5). If two or more image pick-up means are established, the image pick-up direction can be certainly determined from a stereo image, and the amendment is also easy (claim 6). Amendment will become still easier if it has the attitude-sensing means of the image pick-up means itself in addition to these (claim 7).

[0015] Combining claim 1 and claim 2 of this invention is also included by this invention. That is, it has the 1st image analysis means which analyzes an image pick-up image, and the 1st image analysis means which analyzes an resolution picture, 1 or two or more image pick-up direction parameters are amended based on the analysis result of the 1st image analysis means, and 1 or two or more image pick-up direction parameters are amended based on the analysis result of the 2nd image analysis means. analysis of an image pick-up image — the decision of the amount of amendments — 1 [easy] or two or more easy image pick-up direction parameters, and analysis of an resolution picture — the decision of the amount of amendments — it asks for 1 [easy] or two or more easy image pick-up direction parameters with the 1st image analysis means and the 2nd image analysis means, respectively. Thereby, the amount of amendments can be determined easily.

[0016] Moreover, combining claim 4 thru/or claim 7 of this invention is also included by this invention. For example, about a thing like fluctuation of only camera height which causes only fluctuation of only a scale of an resolution picture substantially, the amount of amendments is calculated from relation with a car rate with the means of claim 5, and the other image pick-up direction parameters are amended by claim 4. Moreover, for example, a gyroscope is built into an image pick-up means as an attitude-sensing means of claim 7, from image analysis like angle of torsion, amendment of the difficult image pick-up direction parameter is enabled, and claim 4 or claim 5 amends the other image pick-up direction parameters. In addition, any combination of claim 4 thru/or claim 7 is included by this invention.

[0017]

Embodiment of the Invention] Hereafter, the concrete example of this invention is explained. Although the following examples are examples including amendment of a pitch angle, they are taught by the following example and other configurations of the invention in this application can constitute them easily.

[0018] The [1st example] Drawing 2 is the block diagram showing the configuration of the image pick-up concerning the 1st concrete example of this invention, and image transformation equipment 10. As shown in (a) of drawing 8 , it is carried in Car M, and the camera C which picturizes car back is assumed. The image picturized with the camera (image pick-up means) 1 of drawing 2 is inputted into the view transducer (image transformation means) 2. Here, it changes into a bird's-eye view image based on the image pick-up direction parameter which is a initial value. Here, a bird's-eye view image is outputted to the image analysis means 3. The image analysis means 3 consists of the lane-space-marks detecting element 31 and the amount calculation section 32 of parameter amendments. In the lane-space-marks detecting element 31, the lane space marks which it should display as an parallel white line are detected. Here, lane space marks did not become a perpendicular parallel track group among the image, but the inclination may have arisen. Next, in the amount calculation section 32 of parameter amendments, when the inclination has arisen in lane space marks, the amount dP of amendments of the pitch angle Pc of a camera 1 is computed, and it outputs to the view transducer 2. The view transducer 2 performs image transformation again based on the amount dP of amendments of the pitch angle Pc of a camera 1. In this way, it is outputted, after repeating a routine and becoming a right bird's-eye view image until the inclination of the lane space marks which it should display as an parallel white line in a bird's-eye view image is lost.

[0019] An image pick-up and the image transformation equipment 10 of this example make a flow chart the procedure performed as a whole, and it is shown in drawing 3 . S1, S2, etc. and existing "S" mean the step in a flow chart. By S1, the image which the camera 1 picturized is captured first. Next, by S2, view conversion is performed using the image pick-up direction parameter. Even this is an operation of the view transducer 2. Next, two lane space marks are detected from a bird's-eye view image by S3. Next, by S4, width of face Wi1 and Wi2 of two places of lane space marks is computed. Next, the difference of width of face Wi1 and Wi2 is searched for by S5. If it becomes Wi1=Wi2, it will progress to S6 and a bird's-eye view image will be outputted. If it becomes Wi1 !=Wi2, since there is an

nclination of lane space marks, it progresses to S7, and the amount dP of amendments of the pitch angle Pc is computed, it progresses o S8, the pitch angle Pc of the image pick-up direction parameter is replaced with Pc+dP, and it returns to S2.

0020] The approach of computing the amount dP of amendments of the pitch angle Pc of a camera 1 from the inclination of the lane space marks of a bird's-eye view image is as follows. As shown in (a) of drawing 4 , the foot of perpendicular taken down to the road surface G is set to G1 from the camera C formed in height h, and the range included in a bird's-eye view image is carried out to from G1 o back G2. The magnitude of angle G1CG2 is placed with P. Moreover, as shown in (b) of drawing 4 , points R1 and R2 are assumed rom a point G1 and a point G2 to G1G2 in the location of the perpendicular this side W. If the image pick-up direction parameter of the iew transducer 2 of drawing 2 is in agreement with the actual image pick-up direction parameter of the camera C of drawing 4 , die-ength I(G1) I (R1) and I(G2) I (R2) are equal about the corresponding points I (G1), I (G2), I (R1), and I (R2) in the bird's-eye view image of points G1, G2, R1, and R2.

0021] Next, the case where the pitch angle Pc of Camera C shifts dP is assumed. namely, (a) of drawing 4 — like — the angle G1 of nagnitude P — 'CG2' — angle G1 — it is assumed that only CG2 and dP shifted. at this time, as for the field of the square drill surrounded by angle G1CR1 of magnitude theta 1, and angle G2CR2 of magnitude theta 2, the pitch angle Pc of Camera C shifts dP — he angle G1 of magnitude theta 1 — 'CR1' and the angle G2 of magnitude theta 2 — it changes to the field of the square drill surrounded by 'CR2'. The following relation will be realized if it sets here with G1R1=G2R2=W, G1'R1' =W+dW1, and G2'R2' =W+dW2.

Equation 1]

$$W = h \tan \theta_1 \qquad \cdots (1-1)$$

$$W + dW_1 = \frac{h}{\cos dP} \tan \theta_1 \qquad \cdots (1-2)$$

$$W = \frac{h}{\cos P} \tan \theta_2 \qquad \cdots (1-3)$$

$$W + dW_2 = \frac{h}{\cos (P+dP)} \tan \theta_2 \qquad \cdots (1-4)$$

0022] Here, if dP is small enough, it can set as follows.

Equation 2]

$$\cos dP = 1 \qquad \cdots (2-1)$$

$$\cos (P+dP) = \cos P - \sin P dP \qquad \cdots (2-2)$$

0023] dW1 and dP can be calculated as follows using a formula (2-1) and a formula (2-2) from a formula (1-1), (1-2) and a formula (1-), and a formula (1-4).

Equation 3]

$$W_1 = 0 \qquad \cdots (3-1)$$

$$dP = \frac{dW_2}{W + dW_2} \frac{1}{\tan P} \qquad \cdots (3-2)$$

0024] Now, it thinks of what since these are the relation in a real-image system, has happened to them by the bird's-eye view image. rawing 4 — (— c —) — like — a point — G — one — ' — G — two — ' — R — one — ' — R — two — ' — a bird's-eye view — an nage — corresponding points — I (G1') — I (G2') — I (R1') — I (R2') — ******** — die-length I(G1') I (R1') and I(G2') I (R2') — being qual . now, segment G2'R2' of real-image system top — Point r — G2' — if it takes so that it may become r=W, corresponding-points in the bird's-eye view image of Point r] I (r) is located on segment I(G2') I (R2') in a bird's-eye view image. completely — being the ame — things — a point — R — one — R — two — R — one — ' — R — two — ' — r — a straight line — G — one — G — two — xial symmetry — a point — L — one — L — two — L — one — ' — L — two — ' — I — ******** — carrying out . Then, when the ane space marks of two parallel straight lines of width-of-face 2W of the straight line which passes along Points R1, R2, and r, and the traight line which passes along Points L1, L2, and I are assumed, it is clearer than a formula (3-1) point R1' and that point L1''s it is on ane space marks respectively. Therefore, lane space marks like the thick wire of (c) of drawing 4 can be assumed.

0025] Like the already described JP,2946727,B publication, a bird's-eye view image changes the image pick-up image of a Gaussian naging system, and its ratio of the segment in the bird's-eye view image corresponds with the ratio of the segment in the real-image ystem in the direction of an axis of abscissa (it is the direction of [on a perpendicular road surface] to the image pick-up center line f a camera). Therefore, the ratio of dW2=rR2' of a real-image system and G2'R2' =W+dW2 Are equal to the ratio of I(r) I (R2') in a ird's-eye view image, and I(G2') I (R2'). I(R2') I(L2')-I (r) It is equal to the ratio of I (I), (=2I(r) I (R2')), and I(L2') I (R2') (=2I(G2') I (R2')). If sets with I(L2') I(R2') =I(L1') I(R1') =Wi1 and I(r) I(I) =Wi2, the formula (3-2) of a real-image system can be replaced by the formula (4) i the following bird's-eye view image.

Equation 4]

$$P = \frac{W_{i1} - W_{i2}}{W_{i1}} \frac{1}{\tan P} \qquad \cdots (4)$$

0026] The place which a formula (4) means is clear. That is, in the lane-space-marks detecting element 31 of the image analysis means of drawing 2 , Bure dP of the camera pitch angle Pc is called for from the width of face Wi1 in the car nearest to the inside of the ird's-eye view image of the lane space marks which continue the detected bird's-eye view image from the car latest to a back distant lace noting that it is the lane space marks which should be parallel lines, the width of face Wi2 in the method of the last in a bird's-eye iew image, and the image pick-up angle P of the lengthwise direction incorporated as a bird's-eye view image in a real-image system. herefore, a right bird's-eye view image can be obtained by transposing the camera pitch angle Pc to Pc+dP among the image pick-up irection parameters, and performing view conversion again, without correcting the image pick-up direction of a camera itself.

0027] The [2nd example] Height h of Camera C considers the case where it changes to h+dh. drawing 4 — setting — ** — the image ick-up angle P of the lengthwise direction similarly incorporated as set-up camera height h and a bird's-eye view image as shown in (a) f drawing 5 is set up. The same is said of points G1, G2, R1, and R2, die-length W, and angles theta1 and theta2. next — drawing 5 —

— b —)' — like — height — h+dh — a point — C — ' — having become — the time — magnitude — theta — one — an angle — G — one — C'R — one — ' — becoming — a point — R — one — ' — a point — G — one — ' — distance — W+dW — one — nagnitude — theta — two — an angle — G — two — C'R — two — ' — becoming — a point — R — two — ' — a point — G — two — ' — distance — W+dW2 — placing . Then, the following relation is realized clearly.

Equation 5]

$$W = h\tan\theta_1 \quad \cdots (5-1)$$

$$W + dW_1 = (h+dh)\tan\theta_1 \quad \cdots (5-2)$$

$$W = \frac{h}{\cos P}\tan\theta_2 \quad \cdots (5-3)$$

$$W + dW_2 = \frac{h+dh}{\cos P}\tan\theta_2 \quad \cdots (5-4)$$

0028] The following relation consists of a formula (5-1) and a formula (5-3).

Equation 6]

$$\tan\theta_1 = \frac{\tan\theta_2}{\cos P} \quad \cdots (6)$$

0029] If a formula (6) is substituted for a formula (5-4), it will become as follows.

Equation 7]

$$(h+dh)\tan\theta_1 = W + dW_2 \quad \cdots (7)$$

0030] A comparison of a formula (5-2) and a formula (7) materializes the following formula.

Equation 8]

$$W_1 = dW_2 \quad \cdots (8)$$

0031] From a formula (8), even if a camera moves to point C' of height h+dh from the point C of height h, being maintained by the ird's-eye view image can understand parallel of lane space marks easily. Therefore, it can ask for the change dh of the height of a amera by the following approaches.

0032] Suppose that the lane space marks which described the slash disappeared from the bird's-eye view image after time amount t as hown in (d) in a bird's-eye view image which is (c) of drawing 5 . If the image analysis means is being interlocked with the rate easurement means of a car here, the distance D which progressed between time amount t will be found. On the other hand, since the nclude angle of a lengthwise direction of the range changed into a bird's-eye view image among the image pick-up range of a camera is ', h+dh, then its distance are cosP(s) (h+dh) about height. It can opt for the fluctuation dh of a camera location from the distance (h+dh) and cosP which progressed between time amount t. In this way, a right bird's-eye view image can be obtained by repeating asking for bird's-eye view image again by making a camera location into h+dh.

0033] The [3rd example] The parameter decision in an image pick-up image is explained briefly. For example, suppose that the image ick-up H of a horizontal line was detected in the image pick-up image. At this time, if the image pick-up H of a horizontal line is level as hown in (a) of drawin

TECHNICAL FIELD

Field of the Invention] This invention relates to the image pick-up and image transformation equipment which change into an resolution picture the image pick-up image picturized by the image pick-up means with an image transformation means, and output it. What changes the image pick-up image specifically obtained by picturizing a road surface etc. aslant into the top view picturized and obtained from the upper part before outputting to for example, image recognition equipment is mentioned. This invention is effective in the image pick-up which provides an operator etc. with the top view (bird's-eye view) from the upper part in operation of operation of a car etc., a vessel, the aircraft, etc., and external observation especially, and especially image transformation equipment.

Translation done.]

PRIOR ART

[Description of the Prior Art] For example, JP,2946727,B and JP,7-218280,A are known as the image pick-up which picturizes the road surface and road situation of the front or back to the operator of a car, and provides him with the top view (bird's-eye view) from the upper part, and image transformation equipment. These fix image pick-up equipment as a design including the image pick-up direction beforehand, and input the parameter.

[Translation done.]

:FFECT OF THE INVENTION

Function and Effect(s) of the Invention] When the image pick-up means has not turned to the image pick-up direction as a setting, it :an ask for the gap with the set point of the image pick-up direction of an image pick-up means by analyzing an image pick-up image or :n resolution picture with the means of claim 1 of this application, or claim 2. Therefore, the amended resolution picture can be acquired y amending the image pick-up direction parameter in an image transformation means, without adjusting the image pick-up means itself. Therefore, fine tuning becomes unnecessary in the case of immobilization of an image pick-up means. As such an image pick-up and nage transformation equipment, after picturizing a road surface etc. aslant, for example, it is effective in especially the image pick-up nd image transformation equipment that form the top view (bird's-eye view) from the upper part. By this, you can make it for example, nage recognition equipment interlocked with, a more exact circumference situation can be recognized, and circumference status nformation can be given to an operator, a monitor, etc.

0014] If an image pick-up means is attached in a car and the image pick-up image or resolution picture of a road surface is analyzed, he amount of amendments of the image pick-up direction parameter can be determined easily (claim 3). According to analysis of the arallel lines on a road surface, a known graphic form, and an optical flow, it is especially easy and certain (claims 4 and 5). If two or nore image pick-up means are established, the image pick-up direction can be certainly determined from a stereo image, and the mendment is also easy (claim 6). Amendment will become still easier if it has the attitude-sensing means of the image pick-up means self in addition to these (claim 7).

0015] Combining claim 1 and claim 2 of this invention is also included by this invention. That is, it has the 1st image analysis means /hich analyzes an image pick-up image, and the 1st image analysis means which analyzes an resolution picture, 1 or two or more image ick-up direction parameters are amended based on the analysis result of the 1st image analysis means, and 1 or two or more image ick-up direction parameters are amended based on the analysis result of the 2nd image analysis means. analysis of an image pick-up nage -- the decision of the amount of amendments -- 1 [easy] or two or more easy image pick-up direction parameters, and analysis f an resolution picture -- the decision of the amount of amendments -- it asks for 1 [easy] or two or more easy image pick-up irection parameters with the 1st image analysis means and the 2nd image analysis means, respectively. Thereby, the amount of mendments can be determined easily.

0016] Moreover, combining claim 4 thru/or claim 7 of this invention is also included by this invention. For example, about a thing like uctuation of only camera height which causes only fluctuation of only a scale of an resolution picture substantially, the amount of mendments is calculated from relation with a car rate with the means of claim 5, and the other image pick-up direction parameters are mended by claim 4. Moreover, for example, a gyroscope is built into an image pick-up means as an attitude-sensing means of claim 7, om image analysis like angle of torsion, amendment of the difficult image pick-up direction parameter is enabled, and claim 4 or claim 5 mends the other image pick-up direction parameters. In addition, any combination of claim 4 thru/or claim 7 is included by this ivention.

0017]

Embodiment of the Invention] Hereafter, the concrete example of this invention is explained. Although the following examples are xamples including amendment of a pitch angle, they are taught by the following example and other configurations of the invention in this pplication can constitute them easily.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Like a passenger car, by a car body's sinking or inclining with the entrainment number and the amount of loads, when the location and the image pick-up direction of image pick-up equipment differ from the parameter inputted or it was designed, in a place, they may happen frequently. Then, while running the road surface which has completely parallel lane space marks, for example, even if it is going to obtain the top view (bird's-eye view) from the upper part from an image pick-up and image transformation equipment, distortion will arise.

0004] This is shown in drawing 8 . As shown in (a) of drawing 8 , when the pitch angle Pc (the apparent vertical passing through the lens core of Camera C and angle which the image pick-up direction of a camera constitutes) of the camera C formed in Car M is alpha, the image pick-up image ((b) of drawing 8) presupposes that the processor is constituted so that it may become a right resolution picture (c) of drawing 8). That is, when the parallel lines on a road surface (a thick segment and broken line) are picturized, an resolution picture presupposes that it is adjusted so that it may become parallel lines. When the pitch angle of a camera becomes large with alpha+d alpha (dalpha> 0) or becomes small with alpha-d alpha (dalpha> 0) at this time, that image pick-up image becomes like (d) of drawing 8 , (a horizontal line H becoming a low location among an image pick-up image), (e), and (a horizontal line H becoming a high location among an image pick-up image). Then, since the approach of image transformation is to change into the frame of the screen of (c) of drawing 8 , (f), and (g) the field surrounded by the dotted line of (b) of drawing 8 , (d), and (e), the resolution picture of (d) of drawing 8 and (e) will become like (f) of drawing 8 , and (g). That is, an resolution picture did not become a top view (bird's-eye view) from the right upper part with the inclination of a car, but there was a problem that right information was not directed to an operator even if it outputs to image recognition equipment.

0005] Accomplishing this invention in order to solve the above-mentioned technical problem, the purpose is offering the image pick-up and image transformation equipment which were constituted so that the resolution picture amended by carrying out automatic amendment of the image pick-up direction of image pick-up equipment might be outputted.

Translation done.]

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.This document has been translated by computer. So the translation may not reflect the original precisely.
.**** shows the word which can not be translated.
.In the drawings, any words are not translated.

IEANS

Means for Solving the Problem] In the image pick-up which has an image pick-up means, an image transformation means to change the nage pick-up image of the image pick-up means, and to output an resolution picture, and an image analysis means to analyze an image ick-up image according to the means according to claim 1 in order to solve the above-mentioned technical problem, and image ansformation equipment It is characterized by constituting so that the image pick-up direction parameter of the image pick-up means hich an image transformation means has based on the analysis result of an image analysis means may be amended and the amended esolution picture may be made to output. This is shown in drawing 1 (a) as a block diagram. In addition, as an image pick-up direction arameter, they are the locations (camera height etc.) of an image pick-up means, the angle (pitch angle) of the direction of an image ick-up core, and the straight line taken down downward [vertical] from the image pick-up means to accomplish, the angle (horizontal ure angle) of those flat surfaces to make and the direction of a setting image pick-up core set up to accomplish, and angle of torsion f the image pick-up means centering on the direction of an image pick-up core.

0007] Moreover, an image transformation means to change the image pick-up image of an image pick-up means and its image pick-up ieans according to the means according to claim 2, and to output an resolution picture, In the image pick-up which has an image nalysis means to analyze the resolution picture which the image transformation means outputs, and image transformation equipment It characterized by constituting so that the image pick-up direction parameter of the image pick-up means which an image ansformation means has based on the analysis result of an image analysis means may be amended and the amended resolution picture ıay be made to output. This is shown in drawing 1 (b) as a block diagram. In addition, as an image pick-up direction parameter, they are ne locations (camera height etc.) of an image pick-up means, the angle (pitch angle) of the direction of an image pick-up core, and the traight line taken down downward [vertical] from the image pick-up means to accomplish, the angle (horizontal Bure angle) of those at surfaces to make and the direction of a setting image pick-up core set up to accomplish, and angle of torsion of the image pick-up ieans centering on the direction of an image pick-up core.

0008] Moreover, according to the means according to claim 3, in an image pick-up according to claim 1 or 2 and image transformation quipment, it is characterized by attaching an image pick-up means in a car, and mainly picturizing a road surface. In addition, a road urface is not limited to the so-called road, but means all the fields where a car moves. That is, a parking field is included.

0009] Moreover, according to the means according to claim 4, an image analysis means presumes and extracts the parallel lines or the nown graphic form on a road surface, and is characterized by determining the amount of amendments of the image pick-up direction arameter by analyzing the image pick-up image or resolution picture of these parallel lines or a known graphic form. Road surface-like arallel lines mean the road shoulder, lane space marks, a parking field partition line, etc., and a known graphic form means road surface ispplay of a circular manhole, a stop line, and a travelling direction and others etc. here, for example.

0010] Moreover, according to the means according to claim 5, an image analysis means is characterized by determining the amount of mendments of the image pick-up direction parameter by the rate measurement means of a car being interlocked with by analyzing the nage pick-up image or resolution picture of an optical flow on a road surface. An optical flow means what is recognized by the image nalysis means as what moves in an image pick-up image or resolution picture top here like the lane space marks of the shape of a roken line formed in the road surface.

0011] Moreover, according to the means according to claim 6, it has predetermined distance, two or more image pick-up means are rranged, and an image analysis means is characterized by determining the amount of amendments of the image pick-up direction arameter by analyzing the image pick-up image of the image pick-up means of these plurality, or the resolution picture by said image ansformation means.

0012] Moreover, according to the means according to claim 7, it is characterized by for an attitude-sensing means to detect the irection of an image pick-up means being arranged by the image pick-up means, using together the direction parameter of the image ick-up means against the car which this attitude-sensing means detects, and determining the amount of amendments of the image ick-up direction parameter. An attitude-sensing means means the combination and others of a gyroscope, an acceleration detector, nd a computing element here.

Translation done.]

EXAMPLE

The [1st example] Drawing 2 is the block diagram showing the configuration of the image pick-up concerning the 1st concrete example of this invention, and image transformation equipment 10. As shown in (a) of drawing 8 , it is carried in Car M, and the camera C which picturizes car back is assumed. The camera of drawing 2

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)ESCRIPTION OF DRAWINGS

Brief Description of the Drawings]
Drawing 1] The block diagram explaining the contents of claim 1 of this invention, and claim 2.
Drawing 2] The block diagram showing the configuration of the 1st concrete example of this invention.
Drawing 3] The flow chart which shows the procedure of the 1st example.
Drawing 4] The physical relationship Fig. for explaining the contents of an operation of the 1st example.
Drawing 5] The physical relationship Fig. for explaining the 2nd example.
Drawing 6] The conceptual diagram showing the image pick-up image for explaining the 3rd example.
Drawing 7] The conceptual diagram showing the image pick-up image and bird's-eye view image for explaining the 5th example.
Drawing 8] The explanatory view showing the gap of a pitch angle when not amending, and the relation of a bird's-eye view.
Description of Notations]
! Car
: A camera and a camera location
i Road surface
'c Camera pitch angle
l The image pick-up image of a horizontal line
' The camera image pick-up angle of the lengthwise direction incorporated by the bird's-eye view image

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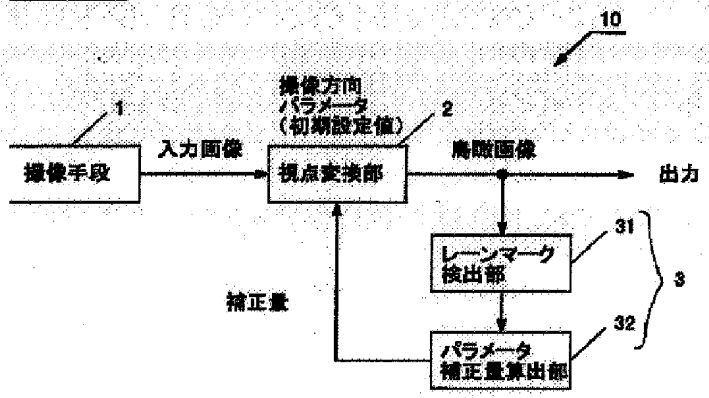
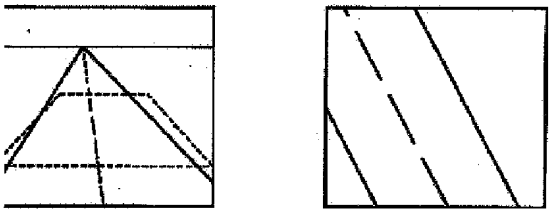
DRAWINGS

Drawing 2]



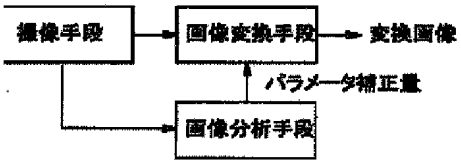
Drawing 7]

(a) (b)

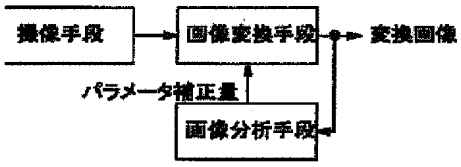


Drawing 1]

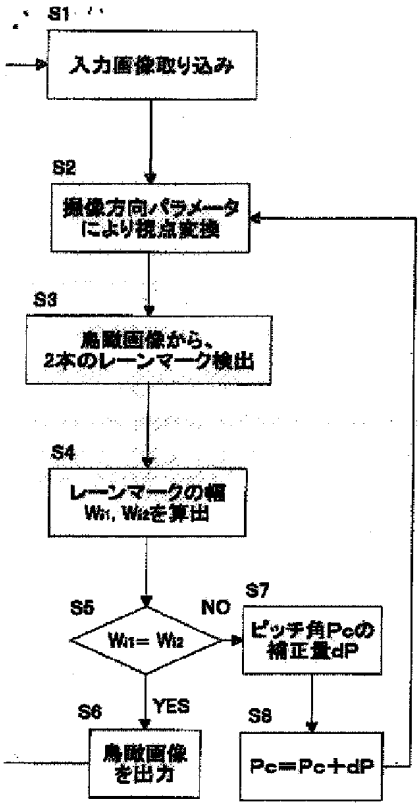
(a)



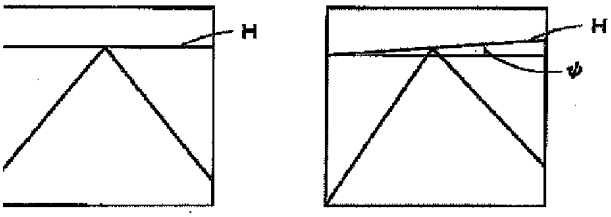
(b)



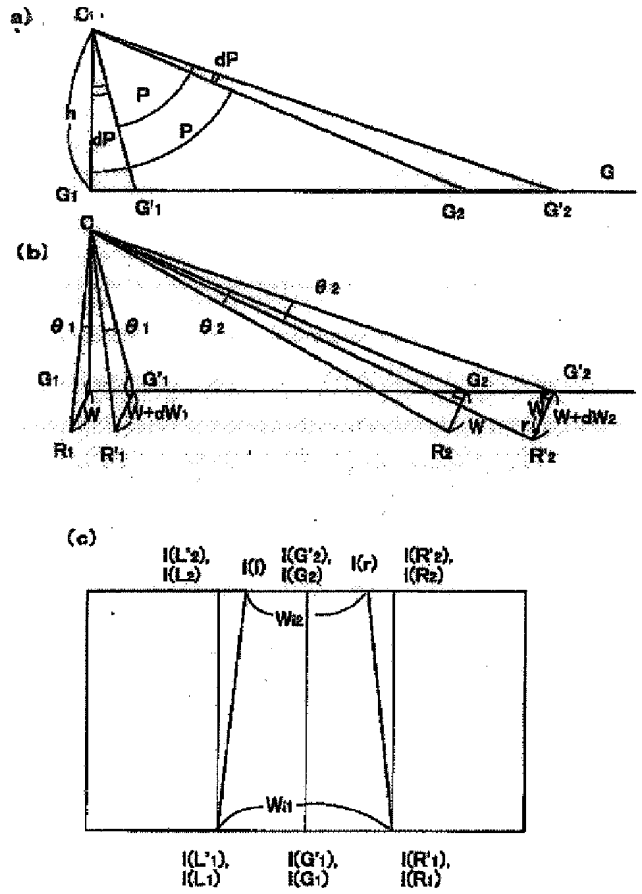
Drawing 3]



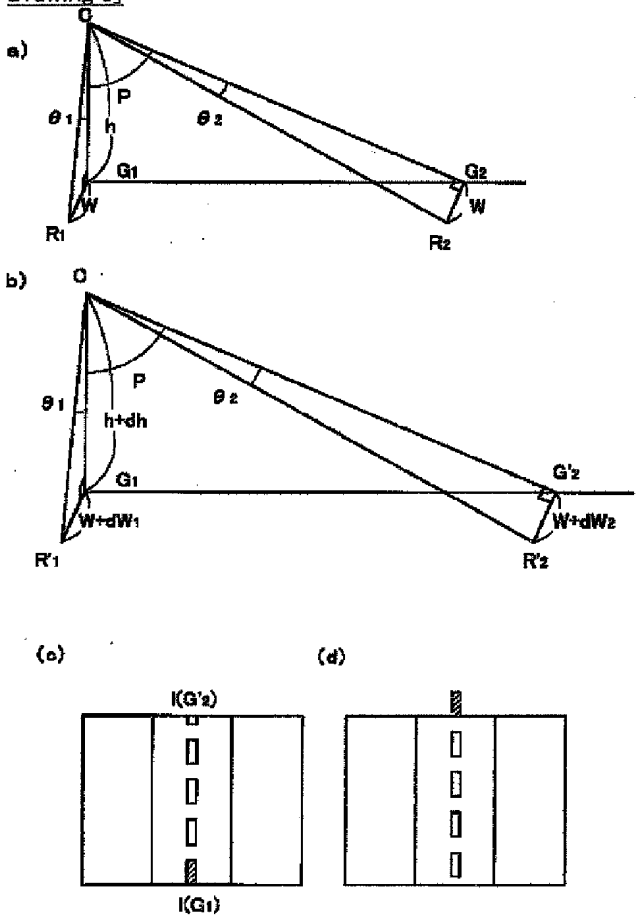
Drawing 6]



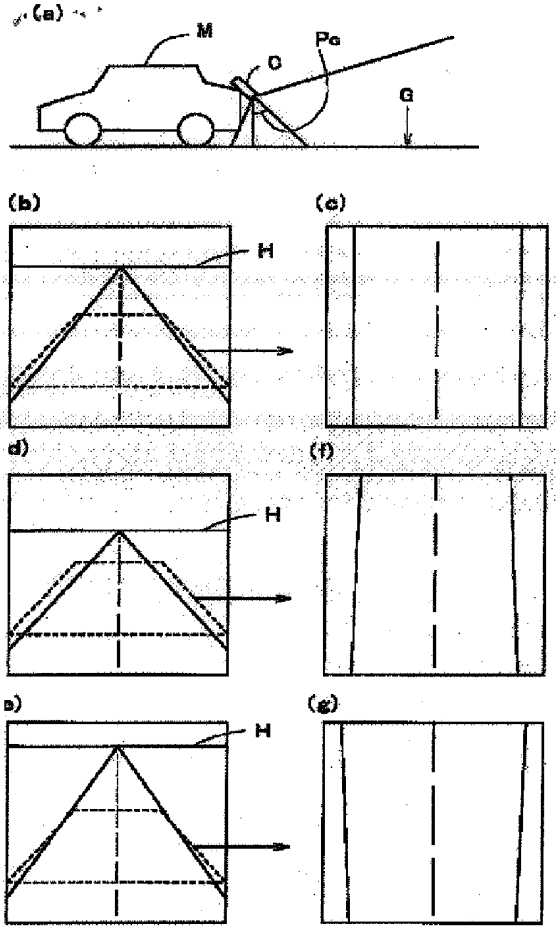
Drawing 4]



Drawing 5]



Drawing 8]



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	7/20			7/20	Ｂ	５Ｃ０５４
Ｇ０８Ｇ	1/16		Ｇ０８Ｇ	1/16	Ｃ	５Ｈ１８０
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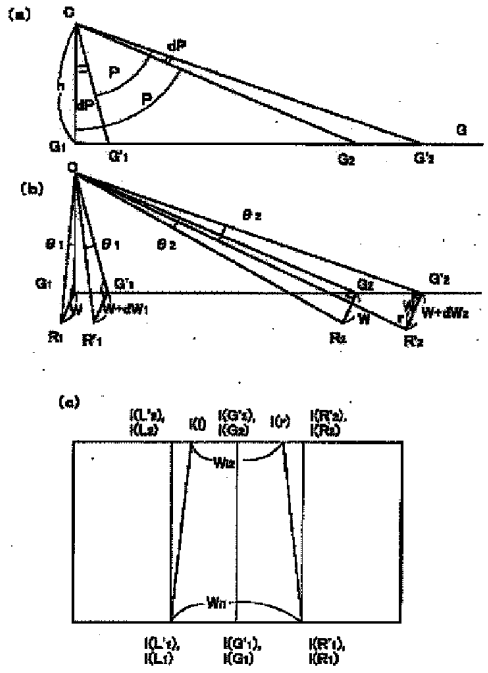
(54)【発明の名称】　撮像及び画像変換装置

(57)【要約】
【課題】　カメラピッチ角の変動を撮像したレーンマークから検出し、変換画像において自動調整すること。
【解決手段】　車両に搭載された高さｈの点Ｃに固定され、カメラから車両後方の路面を撮像し、鳥瞰画像に変換する撮像及び画像変換装置において、平行線であるべきレーンマークを検出し、レーンマークが平行線となっているかどうかを判定する。平行線となっていない場合は、鳥瞰画像において車両に最も近い位置での幅W_{l1}、車両から最も遠い位置での幅W_{l2}、鳥瞰画像に変換する領域をカメラの縦方向の角度Ｐから、カメラピッチ角Ｐｃの変動ｄＰを求め、カメラピッチ角をＰｃ＋ｄＰと置いて鳥瞰画像を再度作成する。



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【特許請求の範囲】

【請求項１】　撮像手段と、その撮像手段の撮像画像を変換して変換画像を出力する画像変換手段と、前記撮像画像を分析する画像分析手段とを有する撮像及び画像変換装置において、

前記画像分析手段の分析結果を基に前記画像変換手段の有する撮像手段の撮像方向パラメータを補正して、補正された変換画像を出力させるよう構成したことを特徴とする撮像及び画像変換装置。

【請求項２】　撮像手段と、その撮像手段の撮像画像を変換して変換画像を出力する画像変換手段と、その画像変換手段の出力する変換画像を分析する画像分析手段とを有する撮像及び画像変換装置において、

前記画像分析手段の分析結果を基に前記画像変換手段の有する撮像手段の撮像方向パラメータを補正して、補正された変換画像を出力させるよう構成したことを特徴とする撮像及び画像変換装置。

【請求項３】　前記撮像手段は車両に取り付けられ、主として路面を撮像することを特徴とする請求項１又は請求項２に記載の撮像及び画像変換装置。

【請求項４】　前記画像分析手段は、路面上の平行線又は既知図形を推定及び抽出し、該平行線又は既知図形の撮像画像又は変換画像を分析することにより前記撮像方向パラメータの補正量を決定することを特徴とする請求項３に記載の撮像及び画像変換装置。

【請求項５】　前記画像分析手段は、車両の速度測定手段と連動することにより、路面上のオプティカルフローの撮像画像又は変換画像を分析することにより前記撮像方向パラメータの補正量を決定することを特徴とする請求項３に記載の撮像及び画像変換装置。

【請求項６】　前記撮像手段を、所定距離を有して２個以上配設し、前記画像分析手段は、それら複数の撮像手段の撮像画像又は前記画像変換手段による変換画像を分析することにより前記撮像方向パラメータの補正量を決定することを特徴とする請求項３に記載の撮像及び画像変換装置。

【請求項７】　前記撮像手段には、撮像手段の方向を検知する姿勢検知手段が配設されており、該姿勢検知手段の検知する車両に対する撮像手段の方向パラメータを併用して前記撮像方向パラメータの補正量を決定することを特徴とする請求項３乃至請求項６のいずれか１項に記載の撮像及び画像変換装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、撮像手段により撮像された撮像画像を、画像変換手段により変換画像に変換して出力する撮像及び画像変換装置に関する。具体的には、路面等を斜めに撮像することにより得られる撮像画像を、例えば画像認識装置に出力する前に、上方から撮像して得られる平面図に変換するものが挙げられる。

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本発明は、特に車両等の運転、船舶及び航空機等の操縦、外部監視において、運転者等に上方からの平面図（鳥瞰図）を提供する撮像及び画像変換装置に特に有効である。

【０００２】

【従来の技術】例えば車両の運転者に、前方又は後方の路面及び道路状況を撮像して上方からの平面図（鳥瞰図）を提供する撮像及び画像変換装置として、特許２９４６７２７号公報、特開平７－２１８２８０号公報が知られている。これらは、予め設計通りに撮像装置を撮像方向を含めて固定し、パラメータを入力しておくものである。

【０００３】

【発明が解決しようとする課題】ところで、例えば乗用車のように、乗車人数、荷物量によって、車体が沈み込んだり、傾いたりすることにより、撮像装置の位置及び撮像方向が、設計された或いは入力されたパラメータと異なってしまう場合は頻繁に起こり得る。すると、例えば完全に平行なレーンマークを有する路面を走行中に、その上方からの平面図（鳥瞰図）を撮像及び画像変換装置から得ようとしても歪みが生じてしまう。

【０００４】これを図８に示す。図８の（ａ）のように、車両Ｍに設けられたカメラＣのピッチ角Ｐｃ（カメラＣのレンズ中心を通る鉛直線とカメラの撮像方向の成す角）がαであるときに、その撮像画像（図８の（ｂ））が、正しい変換画像（図８の（ｃ））となるよう処理装置が構成されているとする。即ち、路面上の平行線（太い線分及び破線）を撮像した場合に、変換画像は平行線となるように調整されているとする。この時、カメラのピッチ角がα＋ｄα（ｄα＞０）と大きくなったり、α－ｄα（ｄα＞０）と小さくなった場合、その撮像画像が、図８の（ｄ）（水平線Ｈが撮像画像中、低い位置になる）、（ｅ）（水平線Ｈが撮像画像中、高い位置になる）のようになる。すると、画像変換の方法が、例えば図８の（ｂ）、（ｄ）、（ｅ）の点線で囲まれた領域を図８の（ｃ）、（ｆ）、（ｇ）の画面の枠に変換することになっているので、図８の（ｄ）、（ｅ）の変換画像が図８の（ｆ）、（ｇ）のようになってしまう。即ち、車両の傾きによって変換画像が正しい上方からの平面図（鳥瞰図）とならず、画像認識装置に出力しても正しい情報が運転者に指示されないという問題があった。

【０００５】本発明は上記の課題を解決するために成されたものであり、その目的は、撮像装置の撮像方向を自動補正して補正された変換画像を出力するよう構成した撮像及び画像変換装置を提供することである。

【０００６】

【課題を解決するための手段】上記の課題を解決するため請求項１に記載の手段によれば、撮像手段と、その撮像手段の撮像画像を変換して変換画像を出力する画像変

換手段と、撮像画像を分析する画像分析手段とを有する撮像及び画像変換装置において、画像分析手段の分析結果を基に画像変換手段の有する撮像手段の撮像方向パラメータを補正して、補正された変換画像を出力させるよう構成したことを特徴とする。これを図１（ａ）にブロック図として示す。尚、撮像方向パラメータとしては、撮像手段の位置（カメラ高さ等）、撮像中心方向と撮像手段から鉛直下向きに下ろした直線との成す角（ピッチ角）、それらのなす平面と設定されている設定撮像中心方向との成す角（横ブレ角）、及び撮像中心方向を軸とする撮像手段のねじれ角である。

【０００７】また、請求項２に記載の手段によれば、撮像手段と、その撮像手段の撮像画像を変換して変換画像を出力する画像変換手段と、その画像変換手段の出力する変換画像を分析する画像分析手段とを有する撮像及び画像変換装置において、画像分析手段の分析結果を基に画像変換手段の有する撮像手段の撮像方向パラメータを補正して、補正された変換画像を出力させるよう構成したことを特徴とする。これを図１（ｂ）にブロック図として示す。尚、撮像方向パラメータとしては、撮像手段の位置（カメラ高さ等）、撮像中心方向と撮像手段から鉛直下向きに下ろした直線との成す角（ピッチ角）、それらのなす平面と設定されている設定撮像中心方向との成す角（横ブレ角）、及び撮像中心方向を軸とする撮像手段のねじれ角である。

【０００８】また、請求項３に記載の手段によれば、請求項１又は請求項２に記載の撮像及び画像変換装置において、撮像手段は車両に取り付けられ、主として路面を撮像することを特徴とする。尚、路面とはいわゆる道路に限定されず、車両が移動する全ての領域を意味する。即ち駐車領域を含む。

【０００９】また、請求項４に記載の手段によれば、画像分析手段は、路面上の平行線又は既知図形を推定及び抽出し、該平行線又は既知図形の撮像画像又は変換画像を分析することにより撮像方向パラメータの補正量を決定することを特徴とする。ここで路面状の平行線とは、例えば路肩、レーンマーク、駐車領域区分線等を言い、既知図形とは例えば円形のマンホール、停止線及び進行方向その他の路面標示等を言う。

【００１０】また、請求項５に記載の手段によれば、画像分析手段は、車両の速度測定手段と連動することにより、路面上のオプティカルフローの撮像画像又は変換画像を分析することにより撮像方向パラメータの補正量を決定することを特徴とする。ここでオプティカルフローとは、例えば路面に形成された破線状のレーンマークのように、撮像画像又は変換画像上を移動するものとして画像分析手段に認識されるものを言う。

【００１１】また、請求項６に記載の手段によれば、撮像手段を、所定距離を有して２個以上配設し、画像分析手段は、それら複数の撮像手段の撮像画像又は前記画像変換手段による変換画像を分析することにより撮像方向パラメータの補正量を決定することを特徴とする。

【００１２】また、請求項７に記載の手段によれば、撮像手段には、撮像手段の方向を検知する姿勢検知手段が配設されており、該姿勢検知手段の検知する車両に対する撮像手段の方向パラメータを併用して撮像方向パラメータの補正量を決定することを特徴とする。ここで姿勢検知手段とはジャイロ、加速度検知器と演算器との組み合わせその他を言う。

【００１３】

【作用及び発明の効果】撮像手段が設定通りの撮像方向を向いていない場合においても、本願の請求項１又は請求項２の手段により、撮像画像又は変換画像を分析することにより撮像手段の撮像方向の設定値とのずれを求めることができる。よって、撮像手段自体を調整することなく、画像変換手段における撮像方向パラメータを補正することにより、補正された変換画像を得ることができる。よって、撮像手段の固定の際においても、微調整が不要となる。このような撮像及び画像変換装置としては、例えば路面等を斜めに撮像した後、上方からの平面図（鳥瞰図）を形成する撮像及び画像変換装置に特に有効である。これにより、例えば画像認識装置と連動させて、より的確な周辺状況の認識を行い、運転者、監視者等に周辺状況情報を与えることができる。

【００１４】撮像手段が車両に取り付けられ、路面の撮像画像或いは変換画像を分析するならば、容易に撮像方向パラメータの補正量を決定できる（請求項３）。特に路面上の平行線、既知図形、オプティカルフローの分析によれば、容易且つ確実である（請求項４、５）。撮像手段を複数設ければステレオ画像から撮像方向を確実に決定でき、その補正も容易である（請求項６）。これらに加え、撮像手段自体の姿勢検知手段を有していれば、補正は更に容易となる（請求項７）。

【００１５】本発明の請求項１と請求項２とを組み合わせることも本発明に包含される。即ち、撮像画像を分析する第１の画像分析手段と、変換画像を分析する第１の画像分析手段とを有し、第１の画像分析手段の分析結果を基に１又は複数の撮像方向パラメータを補正し、第２の画像分析手段の分析結果を基に１又は複数の撮像方向パラメータを補正するものである。撮像画像の分析により補正量の決定容易な１又は複数の撮像方向パラメータと、変換画像の分析により補正量の決定容易な１又は複数の撮像方向パラメータとをそれぞれ第１の画像分析手段、第２の画像分析手段とにより求めるものである。これにより、容易に補正量の決定が行える。

【００１６】また、本発明の請求項４乃至請求項７を組み合わせることも本発明に包含される。例えば、カメラ高さのみの変動のような、実質的に変換画像の縮尺のみの変動しか起こさないものについて、請求項５の手段により車両速度との関係から補正量を求め、その他の撮像

方向パラメータを請求項４により補正するものである。また、例えば、請求項７の姿勢検知手段としてジャイロを撮像手段に組み込み、ねじれ角のような画像分析からは困難な撮像方向パラメータを補正可能とし、その他の撮像方向パラメータを請求項４又は請求項５により補正するものである。この他請求項４乃至請求項７のいずれの組み合わせも本発明に包含される。

【００１７】

【発明の実施の形態】以下、本発明の具体的な実施例について説明する。下記実施例はピッチ角の補正をはじめとする具体例であるが、本願発明の他の構成についても、下記実施例に習って容易に構成できる。

【００１８】〔第１実施例〕図２は、本発明の具体的な第１の実施例に係る撮像及び画像変換装置１０の構成を示すブロック図である。図８の（ａ）のように車両Ｍに搭載され、車両後方を撮像するカメラＣを想定する。図２のカメラ（撮像手段）１により撮像された画像が視点変換部（画像変換手段）２に入力される。ここでは、初期設定値である撮像方向パラメータを基に鳥瞰画像に変換する。ここで、鳥瞰画像が画像分析手段３に出力される。画像分析手段３は、レーンマーク検出部３１とパラメータ補正量算出部３２とから成る。レーンマーク検出部３１においては、平行な白色線として標示されるべきレーンマークを検出する。ここで、レーンマークが画像中、垂直な平行線群とならず、傾きが生じている場合もあり得る。次にパラメータ補正量算出部３２において、レーンマークに傾きが生じている場合にカメラ１のピッチ角Ｐｃの補正量ｄＰを算出して視点変換部２に出力する。視点変換部２はカメラ１のピッチ角Ｐｃの補正量ｄＰを基に再度画像変換を行う。こうして、鳥瞰画像中の平行な白色線として標示されるべきレーンマークの傾きが無くなるまでルーチンが繰り返され、正しい鳥瞰画像となった後、出力される。

【００１９】本実施例の撮像及び画像変換装置１０が全体として行う手順をフローチャートとして図３に示す。Ｓ１、Ｓ２などとある「Ｓ」はフローチャートにおけるステップを意味する。まずＳ１で、カメラ１の撮像した画像を取り込む。次にＳ２で、撮像方向パラメータを用いて視点変換を行う。ここまでが視点変換部２の作用である。次に、Ｓ３で、鳥瞰画像から２本のレーンマークを検出する。次にＳ４で、レーンマークの２箇所の幅W_{i1}、W_{i2}を算出する。次にＳ５で幅W_{i1}、W_{i2}の差を求める。$W_{i1}=W_{i2}$ならばＳ６に進み、鳥瞰画像を出力する。$W_{i1}\neq W_{i2}$ならば、レーンマークの傾きがあるので、Ｓ７に進み、ピッチ角Ｐｃの補正量ｄＰを算出してＳ８に進み、撮像方向パラメータのピッチ角ＰｃをＰｃ＋ｄＰと置き替えてＳ２に戻る。

【００２０】鳥瞰画像のレーンマークの傾きからカメラ１のピッチ角Ｐｃの補正量ｄＰを算出する方法は以下の通りである。図４の（ａ）のように、高さｈに設けられたカメラＣから、路面Ｇに対して下ろした垂線の足をG_1とし、鳥瞰画像に入る範囲をG_1から後方G_2までとする。角G_1CG_2の大きさをＰと置く。また、図４の（ｂ）のように、点G_1、点G_2から、G_1G_2に垂直手前Ｗの位置に点R_1、R_2を想定する。図２の視点変換部２の撮像方向パラメータが、図４のカメラＣの実際の撮像方向パラメータと一致しているならば、点G_1、G_2、R_1、R_2の鳥瞰画像での対応点Ｉ(G_1)、Ｉ(G_2)、Ｉ(R_1)、Ｉ(R_2)について、長さＩ(G_1)Ｉ(R_1)とＩ(G_2)Ｉ(R_2)は等しい。

【００２１】次に、カメラＣのピッチ角ＰｃがｄＰずれた場合を想定する。即ち、図４の（ａ）のように、大きさＰの角$G_1'CG_2'$が、角G_1CG_2とｄＰだけずれたものと想定する。この時、大きさθ_1の角G_1CR_1と、大きさθ_2の角G_2CR_2とで囲まれる四角錐の領域は、カメラＣのピッチ角ＰｃがｄＰずれることにより大きさθ_1の角$G_1'CR_1'$と、大きさθ_2の角$G_2'CR_2'$とで囲まれる四角錐の領域に変化する。ここで$G_1R_1=G_2R_2=W$、$G_1'R_1'=W+dW_1$、$G_2'R_2'=W+dW_2$とおくと、次の関係が成り立つ。

【数１】

$$W=h\tan\theta_1 \qquad \cdots(1-1)$$

$$W+dW_1=\frac{h}{\cos dP}\tan\theta_1 \qquad \cdots(1-2)$$

$$W=\frac{h}{\cos P}\tan\theta_2 \qquad \cdots(1-3)$$

$$W+dW_2=\frac{h}{\cos(P+dP)}\tan\theta_2 \qquad \cdots(1-4)$$

【００２２】ここで、ｄＰが十分小さいとすれば、次のようにおける。

【数２】

$$\cos dP=1 \qquad \cdots(2-1)$$

$$\cos(P+dP)=\cos P-\sin P dP \qquad \cdots(2-2)$$

【００２３】式（２－１）及び式（２－２）を使って、式（１－１）と（１－２）、式（１－３）と式（１－４）とから、dW_iとｄＰを次のように求めることができる。

【数３】

$$dW_1=0 \qquad \cdots(3-1)$$

$$dP=\frac{dW_2}{W+dW_2}\frac{1}{\tan P} \qquad \cdots(3-2)$$

【００２４】さて、これらは実像系での関係なので、鳥瞰画像でどうなっているのかを考える。図４の（ｃ）のように、点G_1'、G_2'、R_1'、R_2'の鳥瞰画像での対応点Ｉ(G_1')、Ｉ(G_2')、Ｉ(R_1')、Ｉ(R_2')について、長さＩ(G_1')Ｉ(R_1')とＩ(G_2')Ｉ(R_2')は等しい。さて、実像系の線分$G_2'R_2'$上に、点ｒを、$G_2'r=W$と

なるようにとると、点ｒの鳥瞰画像での対応点Ｉ（ｒ）は、鳥瞰画像中で線分Ｉ（G_2'）Ｉ（R_2'）上に位置する。全く同様なことを点R_1、R_2、R_1'、R_2'、ｒの直線G_1G_2での線対称点L_1、L_2、L_1'、L_2'、ｌについて行う。すると、点R_1、R_2、ｒを通る直線と、点L_1、L_2、ｌを通る直線の、幅２Ｗの平行な２直線のレーンマークを想定すると、式（３－１）より点R_1'、点L_1'は各々レーンマーク上にあることは明らか。よって、図４の（ｃ）の太線のようなレーンマークを想定することができる。

【００２５】既に述べた特許２９４６７２７号記載のように、鳥瞰画像はガウス結像系の撮像画像を変換するものであり、その鳥瞰画像における線分の比は、横軸方向（カメラの撮像中心線に対して垂直な路面上の方向）での実像系における線分の比と一致する。よって、実像系のｄW_2＝ｒR_2'とG_2'R_2'＝Ｗ＋ｄW_2の比は、鳥瞰画像におけるＩ（ｒ）Ｉ（R_2'）とＩ（G_2'）Ｉ（R_2'）の比に等しく、Ｉ（R_2'）Ｉ（L_2'）－Ｉ（ｒ）Ｉ（ｌ）（＝２Ｉ（ｒ）Ｉ（R_2'））とＩ（L_2'）Ｉ（R_2'）（＝２Ｉ（G_2'）Ｉ（R_2'））の比に等しい。Ｉ（L_2'）Ｉ（R_2'）＝Ｉ（L_1'）Ｉ（R_1'）＝W_{i1}、Ｉ（ｒ）Ｉ（ｌ）＝W_{i2}とおけば、実像系の式（３－２）は次の鳥瞰画像での式（４）で置き替えることができる。

【数４】

$$dP = \frac{W_{i1} - W_{i2}}{W_{i1}} \frac{1}{\tan P} \qquad \cdots (4)$$

【００２６】式（４）の意味するところは明らかである。即ち、図２の画像分析手段３のレーンマーク検出部３１において、平行線であるべきレーンマークであるとして検出された鳥瞰画像を車両直近から後方遠方へ続くレーンマークの、鳥瞰画像中での車両直近での幅W_{i1}と、鳥瞰画像中最後方での幅W_{i2}、及び実像系における鳥瞰画像として取り込まれる縦方向の撮像角Ｐとから、カメラピッチ角Ｐｃのブレｄ Ｐが求められる。よって、撮像方向パラメータのうち、カメラピッチ角Ｐｃを Ｐｃ＋ｄＰに置き替えて視点変換を再度行うことで、カメラの撮像方向自体を修正することなく、正しい鳥瞰画像を得ることができる。

【００２７】〔第２実施例〕カメラＣの高さｈが、ｈ＋ｄｈに変化した場合を考える。図４においてと同様、図５の（ａ）のように、設定されたカメラ高さｈと鳥瞰画像として取り込まれる縦方向の撮像角Ｐを設定する。点G_1、G_2、R_1、R_2、長さＷ、角θ_1、θ_2も同様である。次に図５の（ｂ）のように、高さがｈ＋ｄｈの点Ｃ'になったとき、大きさθ_1の角G_1Ｃ'R_1'となる点R_1'と点G_1'との距離をＷ＋ｄW_1、大きさθ_2の角G_2Ｃ'R_2'となる点R_2'と点G_2'との距離をＷ＋ｄW_2と置く。すると、次の関係が明らかに成り立つ。

【数５】

$$W = h\tan\theta_1 \qquad \cdots (5-1)$$

$$W + dW_1 = (h+dh)\tan\theta_1 \qquad \cdots (5-2)$$

$$W = \frac{h}{\cos P}\tan\theta_2 \qquad \cdots (5-3)$$

$$W + dW_2 = \frac{h+dh}{\cos P}\tan\theta_2 \qquad \cdots (5-4)$$

【００２８】式（５－１）と式（５－３）から、次の関係が成り立つ。

【数６】

$$\tan\theta_1 = \frac{\tan\theta_2}{\cos P} \qquad \cdots (6)$$

【００２９】式（６）を式（５－４）に代入すると、次のとおりとなる。

【数７】

$$(h+dh)\tan\theta_1 = W + dW_2 \qquad \cdots (7)$$

【００３０】式（５－２）と式（７）を比較すると、次の式が成り立つ。

【数８】

$$dW_1 = dW_2 \qquad \cdots (8)$$

【００３１】式（８）から、カメラが高さｈの点Ｃから高さｈ＋ｄｈの点Ｃ'に移動しても、レーンマークの平行は鳥瞰画像で保たれることが容易に理解できる。よって、カメラの高さの変化ｄｈは、次のような方法で求めることができる。

【００３２】図５の（ｃ）のようであった鳥瞰画像において、斜線を記したレーンマークが時間ｔ後に（ｄ）のように鳥瞰画像から消えたとする。ここで画像分析手段が車両の速度測定手段と連動していれば、時間ｔの間に進んだ距離Ｄが求められる。一方、カメラの撮像範囲のうち鳥瞰画像に変換される範囲は縦方向の角度がＰであるので、高さをｈ＋ｄｈとすれば、その距離は（ｈ＋ｄｈ）cosＰである。時間ｔの間に進んだ距離Ｄと（ｈ＋ｄｈ）cosＰとから、カメラ位置の変動ｄｈを決定することができる。こうして、カメラ位置をｈ＋ｄｈとして鳥瞰画像を再度求めることを繰り返すことで、正しい鳥瞰画像を得ることができる。

【００３３】〔第３実施例〕撮像画像でのパラメータ決定について簡単に説明する。例えば撮像画像中に、水平線の撮像Ｈが検出されたとする。この時、図６の（ａ）のように水平線の撮像Ｈが水平であればカメラの撮像方向にねじれは生じていない。しかし図６の（ｂ）のように水平線の撮像Ｈが水平と角度ϕを成していれば、カメラの撮像方向に大きさϕのねじれが生じていることが検出できる。よってこれを基に、カメラ自体の姿勢を修正することなく、変換画像（鳥瞰画像）において、修正す

ることができる。

【００３４】〔第４実施例〕第３実施例のように水平線の撮像Ｈを検出しにくい場合は多い。例えば地形によるもの、或いは建築物等の障害物が多数ある場合などである。この際、カメラにジャイロが搭載されていれば、その情報を基にカメラの撮像方向のねじれを検出し、カメラ自体の姿勢を修正することなく、変換画像（鳥瞰画像）において、修正することができる。これにより、常にねじれの生じていない画像から、第１及び第２実施例のような鳥瞰画像での修正が容易となる。

【００３５】〔第５実施例〕カメラの撮像方向が水平方向にぶれた場合（横ブレ）の補正を示す。カメラが横ブレを起こすと、撮像画像は図７の（ａ）ようになり、撮像方向パラメータの補正無しに鳥瞰画像に変換すると図７の（ｂ）のようになる。この時、第１実施例や第３実施例によって、ピッチ角Ｐｃやねじれ角が補正済みであり、第２実施例で用いたオプティカルフローから破線のレーンマークが車両の進行方向と一致していると判断された場合は、レーンマークの傾きを補正するよう、カメラの横ブレ角を算出することができる。よってカメラの撮像方向の横ブレを検出し、カメラ自体の姿勢を修正することなく、変換画像（鳥瞰画像）において、修正することができる。

【００３６】〔変形例〕上記第１、第２実施例ではレーンマークを分析対象としているが、例えば路面に記された標示を分析対象としても良い。標示が、車両の進行方向に平行又は垂直な平行線の組や、長方形を含んでいる場合、分析対象として用いやすい。標示としては「車」の字（特に中央の（日）など）、進行方向を示す矢印の矢以外の部分、横断歩道、停止線などが上げられる。

【００３７】本発明は上述の通り、例えば鳥瞰画像のような画像を精度良く得るための撮像及び画像変換装置として効果的である。例えば車両の運転手、施設の監視員に、通常の撮像画像では把握しにくい距離感を、容易に把握できる平面図として提供することができる。これにより、例えば初心者や高齢者等の運転能力の劣るもので＊も、容易に車両を後進させることができる。

【００３８】本発明は鳥瞰画像等の変換画像を視認者に提供するのみでなく、更に画像認識装置に提供することで、撮像された周辺状況のより高度な分析を行うことも可能である。例えば本発明の撮像手段の固定された車両その他の移動体、或いは施設の周辺状況を撮像し、本発明により得られる変換画像を画像認識装置に提供することで、撮像手段固定部分に接近する他の移動物体を検知及び判別し、衝突回避の警報その他の指示を視認者に提供する、高度な周辺状況認識装置にくみ上げることができる。例えば車両に搭載することで、歩行者、障害物、他の車両との接近を運転者に警告する危険防止装置、或いは車間距離の維持、レーン中央走行の維持を可能として車両自動走行装置にも適用することができる。

【図面の簡単な説明】

【図１】本発明の請求項１、請求項２の内容を説明するブロック図。

【図２】本発明の具体的な第１の実施例の構成を示すブロック図。

【図３】第１実施例の手順を示すフローチャート。

【図４】第１実施例の演算内容を説明するための位置関係図。

【図５】第２実施例を説明するための位置関係図。

【図６】第３実施例を説明するための撮像画像を示す概念図。

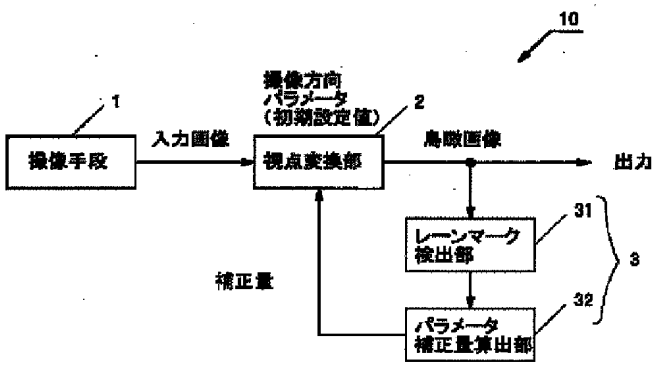
【図７】第５実施例を説明するための撮像画像と鳥瞰画像を示す概念図。

【図８】補正を行わない場合の、ピッチ角のずれと鳥瞰図の関係を示す説明図。

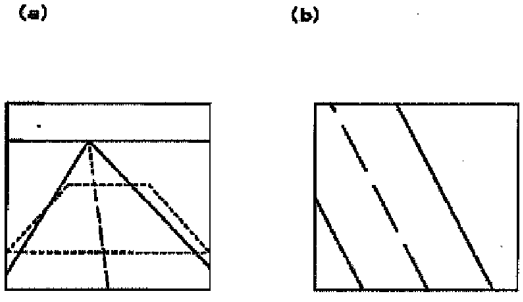
【符号の説明】

Ｍ　車両
Ｃ　カメラ及びカメラ位置
Ｇ　路面
Ｐｃ　カメラピッチ角
Ｈ　水平線の撮像画像
Ｐ　鳥瞰画像に取り込まれる縦方向のカメラ撮像角

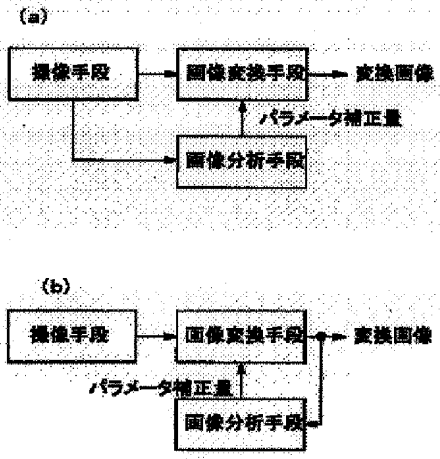
【図２】



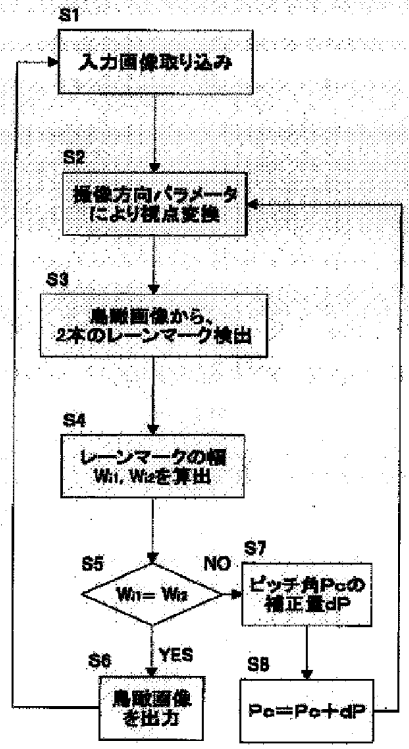
【図７】



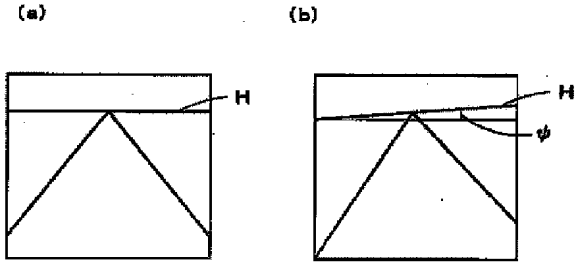
【図１】


(a)
撮像手段
画像変換手段
変換画像
パラメータ補正量
画像分析手段
(b)
撮像手段
画像変換手段
変換画像
パラメータ補正量
画像分析手段

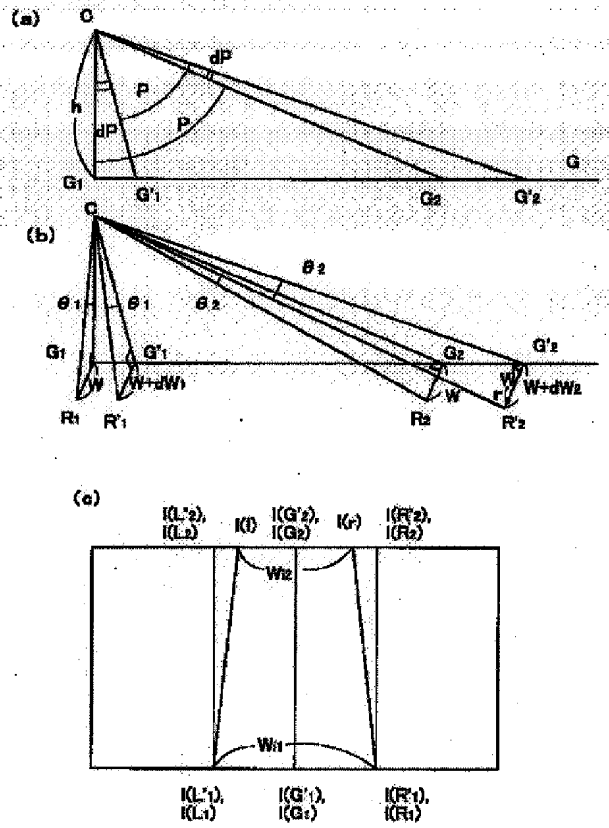
【図３】


S1
入力画像取り込み
S2
撮像方向パラメータにより視点変換
S3
鳥瞰画像から、2本のレーンマーク検出
S4
レーンマークの幅 Wl1, Wl2を算出
S5
Wl1= Wl2
NO
S7
ピッチ角Pαの補正量dP
YES
S6
鳥瞰画像を出力
S8
Pα=Pα+dP

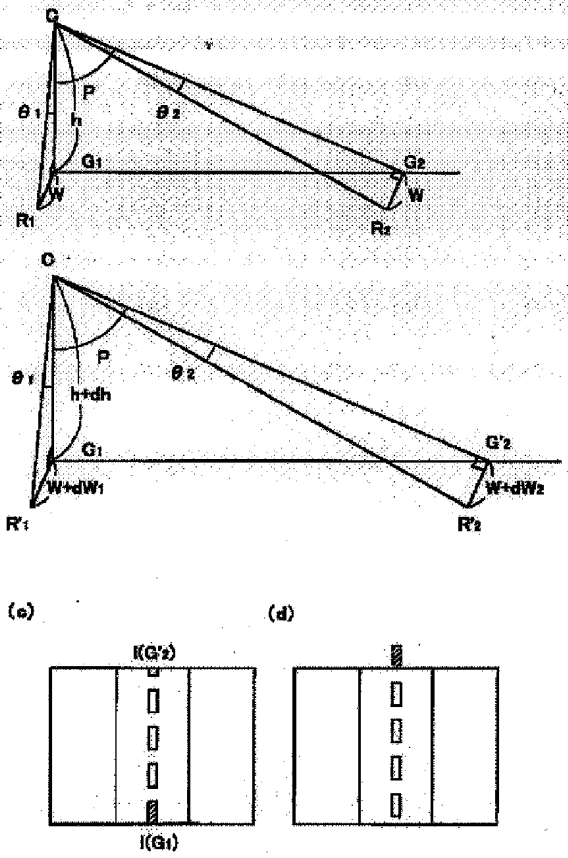
【図６】


(a)
H
(b)
H
ψ

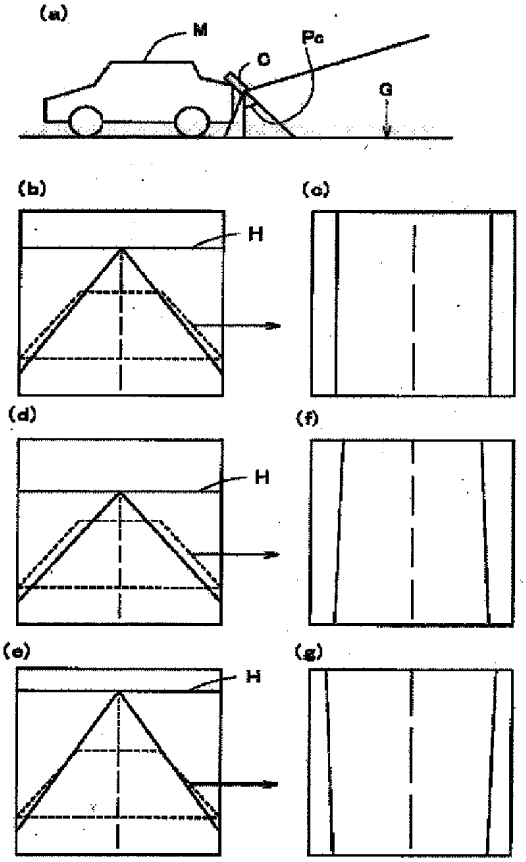
【図４】


(a)
C
dP
P
h
dP
P
G
G1
G'1
G2
G'2
(b)
C
θ1
θ1
θ2
θ2
G1
G'1
G2
G'2
W
W+dW1
W
W+dW2
R1
R'1
R2
R'2
(c)
l(L'2), l(L2)
l(l)
l(G'2), l(G2)
l(r)
l(R'2), l(R2)
W12
W11
l(L'1), l(L1)
l(G'1), l(G1)
l(R'1), l(R1)

【図５】


(a)
C
θ1
P
h
θ2
G1
G2
W
W
R1
R2
(b)
C
θ1
P
θ2
h+dh
G1
G'2
W+dW1
W+dW2
R'1
R'2
(c)
(d)
l(G'2)
l(G1)

【図８】



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CC30
5L096 BA04 CA02 EA07 FA66 FA67
HA02